

# Naval Research Laboratory

Stennis Space Center, MS 39529-5004



NRL/MR/7441--95-7697

## Technical Review of Full Utility Navigation Demonstration Phase 1

LYNN K. KYLE  
S. DANETTE COUGHLAN  
JERRY L. LANDRUM

*Mapping, Charting, and Geodesy Branch  
Marine Geosciences Division*

March 8, 1996

19960401 098

DTIC QUALITY INSPECTED 1

Approved for public release; distribution unlimited.

**REPORT DOCUMENTATION PAGE**Form Approved  
OBM No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

**1. AGENCY USE ONLY (Leave blank)****2. REPORT DATE**

March 8, 1996

**3. REPORT TYPE AND DATES COVERED**

Final

**4. TITLE AND SUBTITLE**

Technical Review of Full Utility Navigation Demonstration Phase 1

**5. FUNDING NUMBERS**

Job Order No. 574-M029-06

Program Element No. M02505

**6. AUTHOR(S)**

Lynn K. Kyle, S. Danette Coughlan, and Jerry L. Landrum

Project No.

Task No.

Accession No.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**Naval Research Laboratory  
Marine Geosciences Division  
Stennis Space Center, MS 39529-5004**8. PERFORMING ORGANIZATION  
REPORT NUMBER**

NRL/MR/7441--95-7697

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**Commander Naval Meteorology and Oceanography Command  
1020 Balch Blvd.  
Stennis Space Center, MS 39529-5005**10. SPONSORING/MONITORING  
AGENCY REPORT NUMBER****11. SUPPLEMENTARY NOTES****12a. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited.

**12b. DISTRIBUTION CODE****13. ABSTRACT (Maximum 200 words)**

The Naval Research Laboratory's Mapping Sciences Branch has been tasked by the Commander Naval Meteorology and Oceanography Command and the Defense Mapping Agency (DMA) to perform software testing of the Full Utility Navigation Demonstration (FUND) software. The FUND software demonstrates the use of DMA's Digital Nautical Chart (DNC) database within an electronic charting system. The FUND software is currently under development by the Naval Command, Control, and Ocean Surveillance Center, In-Service Engineering Division, Norfolk Detachment (NISE East Det Norfolk Code 35).

FUND software is being developed in four phases. This report presents the results of the evaluation of Phase 1 of the four phases.

**14. SUBJECT TERMS**

digital nautical chart, performance standards, specifications

**15. NUMBER OF PAGES**

34

**16. PRICE CODE****17. SECURITY CLASSIFICATION  
OF REPORT**

Unclassified

**18. SECURITY CLASSIFICATION  
OF THIS PAGE**

Unclassified

**19. SECURITY CLASSIFICATION  
OF ABSTRACT**

Unclassified

**20. LIMITATION OF ABSTRACT**

SAR

## **TECHNICAL REVIEW OF FULL UTILITY NAVIGATION DEMONSTRATION (FUND) PHASE 1**

Prepared for:

Commander Naval Meteorology and Oceanography Command (CNMOC)  
and the Defense Mapping Agency (DMA)

prepared by the Naval Research Laboratory (NRL) Code 7441:

Lynn Kyle (601) 688-4628

S. Danette Coughlan (601) 688-4822

Jerry Landrum (601) 688-4613

<b>1.0 INTRODUCTION .....</b>	<b>2</b>
<b>2.0 OVERVIEW .....</b>	<b>3</b>
<b>3.0 IMO PERFORMANCE STANDARDS FOR ECDIS .....</b>	<b>5</b>
3.1 PS REQUIREMENTS .....	5
3.2 PS APPENDIX 2 REQUIREMENTS .....	11
3.3 PS APPENDIX 3 REQUIREMENTS .....	13
<b>4.0 S-52 .....</b>	<b>14</b>
4.1 S-52 REQUIREMENTS .....	14
4.2 S-52 APPENDIX 1 REQUIREMENTS .....	19
4.3 S-52 APPENDIX 2 REQUIREMENTS .....	19
<b>5.0 FUND TASKING .....</b>	<b>25</b>
5.1 REQUIREMENTS FOR PHASE 1 .....	25
5.2 REQUIREMENTS FOR ALL PHASES .....	28
<b>6.0 GENERAL COMMENTS .....</b>	<b>30</b>
<b>7.0 CONCLUSIONS .....</b>	<b>30</b>
<b>8.0 REFERENCES .....</b>	<b>32</b>
<b>9.0 ACKNOWLEDGMENTS .....</b>	<b>33</b>

## **1.0 INTRODUCTION**

The Naval Research Laboratory's Mapping Sciences Branch has been tasked by the Commander Naval Meteorology and Oceanography Command (CNMOC) and the Defense Mapping Agency (DMA) to perform software testing of the Full Utility Navigation Demonstration (FUND) software. The FUND software demonstrates the use of DMA's Digital Nautical Chart (DNC) database within an electronic charting system. The FUND software is currently under development by the Naval Command, Control, and Ocean Surveillance Center, In-Service Engineering Division, Norfolk Detachment (NISE East Det Norfolk Code 35).

FUND software is being developed in four phases. This report presents the results of the evaluation of Phase 1 of the four phases.

## 2.0 OVERVIEW

FUND Phase 1 primarily consists of a route monitoring display with some route planning and voyage recording capabilities. The display presents a nice-looking nautical chart with an easy to use interface, superior graphics, and impressive route monitoring. Overall, FUND seems to be proceeding beyond tasking requirements. Most of the areas of concern presented in this review involve relatively minor issues, and many of the areas of concern are stated multiple times due to redundant stating of the requirements among the three requirements documents.

While the purpose of FUND is only to demonstrate the use of the DNC data product rather than to actually produce an Electronic Chart Display and Information System (ECDIS), the standards that have been produced by the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO) provide a useful set of criteria against which the combination of the DNC database and the FUND software can be evaluated. During the evaluation, the functional capabilities of FUND using DNC were evaluated against the requirements set forth in the following:

1. Performance Standards for ECDIS, International Maritime Organization. Results are presented in Section 3 of the report. Paragraph numbers are prefixed with "PS" and refer to the numbering within the referenced document.
2. Specifications for Chart Content and Display aspects of ECDIS (S-52), International Hydrographic Organization. Results are presented in Section 4 of the report. Paragraph numbers are prefixed with "S" and refer to the numbering within the referenced document.
3. Task Order, DMA to NISE-East, 10 April 95, FUND. Results are presented in Section 5 of the report. Paragraph numbers are prefixed with "PA" and refer to the numbering within the referenced document.

Only those requirements that should be completed at the end of Phase 1 are included. The bracketed numbers at the beginning of each requirement indicate in which phase

evaluation takes place. More than one number indicates that the requirement will be reevaluated at completion of each specified phase. The reader is encouraged to consult the three references for a full statement of the functional requirements.

Section 6 provides comments of a general nature relating to installation, documentation, and operation.

### **3.0 CORRELATION OF FUND PHASE 1 WITH IMO PERFORMANCE STANDARDS FOR ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEMS (ECDIS)**

#### **3.1 IMO Performance Standards ECDIS (PS)**

**PS 1.6 [1-2] -- MARGINAL --** ECDIS should reduce the navigational workload compared to using the paper chart. It should enable the mariner to execute in a convenient and timely manner all route planning, route monitoring and positioning currently performed on paper charts. It should be capable of continuously plotting the ship position.

-- See Section PS 10.5 and PS 10.6 for specific information.

**PS 1.7 [1-4] -- PASS --** ECDIS should have at least the same reliability and availability of presentation as the paper chart published by government authorized hydrographic offices.

**PS 3.1 [1-4] -- PASS --** ECDIS should be capable of displaying all System Electronic Navigational Chart (SENC) information.

**PS 3.2 [1-4] -- FAIL --** SENC information available for display during route planning and route monitoring should be subdivided into the following three categories: Display Base, Standard Display, and All Other Information.

-- The three categories specified in IMO Performance Standards for ECDIS Appendix 2 are not in agreement with those presented by FUND. The Base Display specified by the FUND tasking is referenced to the Display Base in this document, but is not the same. Several items are missing or presented in a fashion that differs from the ECDIS requirements. These are specified in Section 3.2. Another difference between the required layers and the FUND layers involves some blurring of the Standard Display and the Additional Information layer.

**PS 3.3 [1] -- FAIL --** ECDIS should present the Standard Display at any time with a single operator action.

-- Because of the combination of both standard and additional features in the features menu, presenting the Standard Display with a single action is not possible at the present time. This requirement seems to suggest the addition of a "Show Standard Display" control somewhere in the menu.

**PS 3.4 [1] -- FAIL --** When a chart is first displayed on ECDIS, it should provide the Standard Display at the largest scale available in the SENC for the displayed area.

-- Some information which is not part of the Standard Display is displayed by default.

**PS 3.5 [1] -- PASS --** It should be easy to add or remove information from the ECDIS display. It should not be possible to remove information contained in the Display Base.

**PS 3.6 [1,3] -- MARGINAL --** It should be possible for the mariner to select a safety contour from the depth contours provided by the SENC. ECDIS should emphasize the safety contour over the other contours on the display.

-- The mariner selectable safety contour is defined as part of the Display Base as specified by the IMO Performance Standards for ECDIS Appendix 2. However, it is acknowledged that the FUND tasking specifies the safety contour as being developed in Phase 3.

**PS 5 [1] -- MARGINAL --** ECDIS should provide an indication if: the information is displayed at a larger scale than that contained in the Electronic Navigational Chart (ENC); or own ship position is covered by an ENC at a larger scale than that provided by the display.

-- The letter O currently appears next to the scale display when overscale, but this does not seem to operate consistently.



**PS 7.1 [1] -- PASS** -- It should always be possible to display the SENC in a north-up orientation. Other orientations are permitted.

**PS 7.2 [1] -- PASS** -- ECDIS should provide for true motion mode. Other modes are permitted.

**PS 7.3 [1] -- PASS** -- When true motion mode is in use, reset and generation of the neighboring area should take place automatically at a distance from the border of the display determined by the mariner.

**PS 7.4 [1] -- PASS** -- It should be possible to change manually the chart area and the position of own ship relative to the edge of the display.

**PS 8.1 [1] -- MARGINAL** -- IHO recommended colors and symbols should be used to represent SENC information.

-- See Section 4.3 for specific information regarding this requirement.

**PS 8.3 [1-4] -- PASS** -- SENC information, when displayed at the scale specified in the ENC, should use the specified size of symbols, figures, and letters.

-- Verify compliance with International Electrotechnical Commission (IEC) Publication 1174.

**PS 8.4 [1] -- FAIL** -- ECDIS should allow the mariner to select whether own ship is displayed in true scale or as a symbol.

-- This is not yet implemented.

**PS 9.1.2 [1] -- PASS** -- ECDIS should be capable of displaying information for route monitoring.

**PS 9.2 [1] -- PASS --** The effective size of the chart presentation for route monitoring should be at least 270 mm by 270 mm.

**PS 9.4 [1-3] -- PASS --** The method of presentation should ensure that the displayed information is clearly visible to more than one observer in the conditions of light normally experienced on the bridge of the ship by day and by night.

**PS 10.1 [1-3] -- PASS --** It should be possible to carry out route planning and route monitoring in a simple and reliable manner.

**PS 10.2 [1-4] -- MARGINAL --** ECDIS should be designed following ergonomic principles for user-friendly operation.

-- The textual information on the route monitoring display can currently be turned on and off with an F1/F2 toggle. It would be more user-friendly if this were incorporated into the same key. An additional issue involves the need for a key press to turn off the night display, which can be rather difficult to do when light is present.

**PS 10.5 [1] -- FAIL --** Route monitoring.

-- See PS 10.5.1 through PS 10.5.11 for specific issues. Also, the alarms and indications which are part of route monitoring are not scheduled for completion until Phase 3.

**PS 10.5.1 [1] -- FAIL --** For route monitoring the selected route and own ship position should appear whenever the display covers that area.

-- The selected route is not displayed at the present time.

**PS 10.5.11.1 [1] -- PASS --** It should be possible to display time-labels along ship track manually on demand and automatically at intervals selected between 1 and 120 minutes.

**PS 10.5.11.2 [1] -- PASS --** It should be possible to display an adequate number of points, free movable electronic bearing lines, variable and fixed range markers, and other symbols required for navigational purposes and specified in Appendix 3.

-- See Section 3.3 for specific details.

**PS 10.5.12 [1] -- FAIL --** It should be possible to enter the geographical coordinates of any position and then display that position on demand. Also, it should be possible to select any point (features, symbol, or position) on the display and read its geographical coordinates on demand.

-- FUND does not currently support user entry and subsequent display of a geographical position. However, cursor position is included in Heads-Up display.

**PS 10.5.13 [1] -- PASS --** It should be possible to adjust the ship's geographical position manually. This manual adjustment should be noted alphanumerically on the screen, maintained until altered by the mariner, and automatically recorded.

**PS 10.6.1 [1] -- PASS --** ECDIS should store and be able to reproduce certain minimum elements required to reconstruct the navigation and verify the official database used during the previous 12 hours. -- See PS 10.6.1.1 and PS 10.6.1.2 for further information.

**PS 10.6.1.1 [1] -- PASS --** To ensure a record of own ship past track: time, position, heading, and speed.

**PS 10.6.2 [1] -- PASS --** In addition, ECDIS should record the complete track for the entire voyage, with time marks at intervals not exceeding 4 hours.

**PS 10.6.3 [1] -- PASS --** It should not be possible to manipulate or change the recorded information.

**PS 10.6.4 [1] -- PASS --** ECDIS should have a capability to preserve the record of the previous 12 hours and of the voyage track.

### **3.2 PS Appendix 2: SENC Information Available for Display During Route Planning and Route Monitoring (PS A2)**

**PS A2 1** Permanent Display Base consisting of

**PS A2 1.1** [1] -- PASS -- High water coastline.

**PS A2 1.2** [1,3] -- MARGINAL -- Own ship safety contour selected by mariner.

-- This is currently not implemented as a mariner selection, and is not indicated as specified in S-52 Appendix 2. However, Phase 3 tasking indicates that safety contour implementation will be developed at that time.

**PS A2 1.3** [1,3] -- MARGINAL -- Indication of isolated underwater dangers at depths less than the safety contour which lie within the safe waters defined by the safety contour.

-- This cannot be evaluated until mariner-selected safety contour is incorporated.

**PS A2 1.4** [1,3] -- MARGINAL -- Indication of isolated dangers which lie within the safe waters defined by the safety contour.

-- This cannot be evaluated until mariner-selected safety contour is incorporated.

**PS A2 1.5** [1] -- PASS -- Traffic routing systems.

**PS A2 1.6** [1] -- FAIL -- Scale, range, orientation, and display mode.

-- Orientation and display mode are not currently displayed, and scale and range can be turned off during route monitoring. These are required to be permanently displayed as part of Display Base.

**PS A2 1.7** [1] -- FAIL -- Units of depth and height.

-- Not currently displayed.

**PS A2 2** Standard Display, shown when chart is first displayed by ECDIS.

**PS A2 2.1** Display Base. -- See above.

**PS A2 2.2** [1] -- FAIL -- Drying line.

-- Drying line is not currently displayed.

**PS A2 2.3** [1] -- PASS -- Indication of fixed and floating aids to navigation.

**PS A2 2.4** [1] -- PASS -- Boundaries of fairways, channels, etc.

**PS A2 2.5** [1] -- PASS -- Visual and radar conspicuous features.

**PS A2 2.6** [1] -- PASS -- Prohibited and restricted areas.

**PS A2 2.7** [1] -- FAIL -- Chart scale boundaries.

-- All chart boundaries are currently displayed, which is not specified as part of Standard Display. Also scale boundaries are not indicated as specified in S-52 Appendix 2.

**PS A2 2.8** [1] -- PASS -- Indication of cautionary notes.

**PS A2 3** [1] -- MARGINAL -- All other information.

-- Several of these items, such as spot soundings, place names, and ferry routes, are treated as part of the Standard Display. These should be part of a distinct third layer containing features that must be shown on demand and do not appear by default.

### **3.3 PS Appendix 3: Navigational Elements and Parameters (PS A3)**

-- See IEC Publication 1174 for further validation.

**PS A3 .1. [1] - PASS -- Own ship.**

**PS A3 .2.1 [1] -- PASS -- Past track with time marks for primary track.**

**PS A3 .4 [1] -- PASS -- Variable range marker and/or electronic bearing line.**

**PS A3 .5 [1] -- MARGINAL -- Cursor.**

-- The cursor sometimes appears as the wait cursor when no processes seem to be taking place. Also, the user can interact with FUND when the cursor is a wait cursor.

**PS A3 .12 [1] -- PASS -- Danger highlight.**

**PS A3 .14 [1] -- PASS -- Planned course and speed to make good.**

## **4.0 CORRELATION OF FUND PHASE 1 WITH SPECIFICATIONS FOR CHART CONTENT AND DISPLAY ASPECTS OF ECDIS (IHO S-52, DECEMBER 1994)**

### **4.1 S-52: IHO Specifications for Chart Content and Display of ECDIS (S52)**

**S52 3.1b** [1-4] -- MARGINAL -- ENC should include all information relevant to navigation at present depicted on the paper chart.

-- Parts of Display Base need to be added.

**S52 3.1d** [1-4] -- PASS -- Object description and attributes displayed in common language terms.

**S52 3.3b** [1-4] -- PASS -- ECDIS should accept and convert Hydrographic Organization data to own data.

**S52 3.3c** [1-4] -- PASS -- Conversion accomplished in the ECDIS.

**S52 3.4c** [1,3] -- MARGINAL -- If the mariner does not specify a safety contour, this should default to 30 m. If the safety contour specified by the mariner is not in the SENC, the safety contour shown should default to the next deeper contour. If the safety contour in use becomes unavailable due to a change in source data, the safety contour should default to the next deeper contour. In each of the above cases, the mariner should be informed.

-- This is currently not implemented as a mariner selection, and is not indicated as specified in S-52 Appendix 2 Sections 3.2.2b 8a and 3.2.2b . However, Phase 3 tasking indicates that safety contour implementation will be developed at that time.



**S52 3.5c [1] -- MARGINAL --** Data shown on the display should always be of the same scale. If a scale boundary is shown on the display, the information shown in the overscale area should not be relied upon at the scale of the display.

-- The overscale area should be identified as specified in Appendix 2.

**S52 3.7 [1] -- PASS --** Language.

**S52 5.1 [1] -- FAIL --** Display categories for chart information are Display Base, Standard Display, and all other information.

-- See Evaluation of IMO Performance Standards for ECDIS Section 3.2.

**S52 5.3 [1-4] -- PASS --** Priority layers.

**S52 6.3a [1] -- FAIL --** If data from different scales (density) appears on the display, the boundary between different scales should be clearly indicated. The ENC should define each area for which a particular compilation scale applies. It is this scale that should be used when deciding if data are being displayed overscale. A graphical index of the scale boundaries of available data should be shown on demand.

-- The chart boundaries are currently delineated with a bold dotted line. They are marked whether or not a scale change occurs. These lines sometimes appear as solid bold lines until a refresh occurs. Also, no graphical index of scale boundaries is implemented.

**S52 6.3b [1] -- PASS --** Ability to use intermediate scales or zoom in between scales.

**S52 6.3c [1] -- FAIL --** A scale bar should be provided as part of the display base for navigating on a large scale (1:80,000 and larger). This is intended to give an immediate impression of scale and of the proximity of charted objects, rather than for accurate distance measurement, which should be made by means of the cursor. For chart displays

at a scale smaller than 1:80,000, a latitude bar should be shown on the border of the standard display.

-- Although it meets specific FUND Phase 1 goals stated for the scale bar, it is not marked as indicated above. The specifications also seem to stipulate that the bar never changes scale, but continually represent 1.5 nautical miles. Also, no latitude bar is present at smaller scales.

**S52 6.4a1 [1] -- PASS** -- Position units are latitude and longitude in degrees, minutes, and decimal minutes.

**S52 6.4a2 [1] -- PASS** -- Depth units are meters and decimeters.

**S52 6.4a3 [1] -- PASS** -- Height units are meters.

**S52 6.4a4 [1] -- PASS** -- Distance units are nautical miles and decimal miles, or meters.

**S52 6.4a5 [1] -- PASS** -- Speed units are knots and decimal knots.

**S52 6.4b [1] -- FAIL** -- Units used should be indicated in display legend. There should be no ambiguity about the units in use at a particular time.

-- No legend is currently incorporated. See S52 6.5 for additional components of the legend.

**S52 6.5 [1] -- FAIL** -- Standard legend of general information should be available for display on a graphic or text display.

-- See below for specific items to be included.

It should contain at minimum:

**(1) [1] -- FAIL** -- Units for depth.

-- Not specified.

(2) [1] -- FAIL -- Units for height.

-- Not specified.

(3) [1] -- FAIL -- Scale of display.

-- Not specified.

(5) [1] -- FAIL -- Sounding/vertical datum.

-- Not specified.

(6) [1] -- FAIL -- Horizontal datum.

-- Not specified.

(11) [1] -- FAIL -- Date of issue of the ENC.

-- Not specified.

(12) [1] -- FAIL -- Chart projection.

-- Not specified.

**S52 7.2a** [1] -- FAIL -- The units for depth should always be on the same screen as the chart display.

-- The depth units are not present on the chart display.

**S52 7.2b** [1-4] -- FAIL -- The following information:

- Positional data and time;
- legend;
- object description and associated attributes;
- textual information from SENC;
- list of abbreviations (from IHO INT-1);
- result from navigational computations;
- record of ENC updates;
- list of categories which are removed from Standard Display;
- symbol library (see Appendix 2),

should be visual on demand on the same screen as the chart display or on an additional graphic or text display.

-- For Phase 1, the legend, list of abbreviations, and symbol library should be available on demand.

**S52 7.2g\_ [1-4]** -- PASS -- Depth information should be displayed as it has been provided in the ENC and not adjusted by tidal height.

**S52 8 [1-4]** -- PASS -- Minimum configuration.

## **4.2 S-52 Appendix 1: Guidance on Updating the Electronic Navigational Chart**

All updating in FUND is to be developed in Phases 2, 3, and 4. As a result, an evaluation based on this document will not be done at this time.

## **4.3 S-52 Appendix 2: Provisional Color and Symbol Specifications for ECDIS (S52 A2)**

**S52 A2 2.2.3 [1] -- MARGINAL --** Route monitoring display presents only the immediately relevant information clearly and without ambiguity. During route monitoring, alphanumeric characters should be kept to a minimum. Old display should remain visible until the refresh is ready for quick draw.

-- The route monitoring display includes several text fields which are not part of the Standard Display as default. Also, the refresh time seems to be longer than necessary. Perhaps the old display should be displayed for a longer time.

**S52 A2 2.2.4 [1-4] -- PASS --** Important features should always be clear, conspicuous, and always be overwritten on top of the radar image.

**S52 A2 2.2.5 [1-2] -- FAIL --** Priority of information: display base, standard display, and other information.

-- See Section 3.2 for details.

**S52 A2 2.2.5 [1-4] -- PASS --** 11 priority layers.

**S52 A2 2.2.6** [1,3] -- PASS -- Size of lines and symbols should be viewable at 70 cm for route planning. Important chart features should be visible from several meters for route monitoring.

**S52 A2 2.2.9** [1-4] -- PASS -- Rules for displaying text.

**S52 A2 2.2.11** [1-4] -- PASS -- Operator control of information should be effective and simple.

**S52 A2 3.1.2** [1-2] -- MARGINAL -- Symbols should not be drawn smaller than specified in the Presentation Library.

-- Currently symbols are drawn smaller as the scale decreases. Further investigation of the validity of symbol size is necessary.

**S52 A2 3.1.3a** [1] -- PASS -- During route monitoring it should be possible to call up additional information quickly and simply when needed.

**S52 A2 3.1.3a** [1] -- PASS -- During route monitoring the system should acknowledge operator instructions immediately.

**S52 A2 3.1.4** [1] -- FAIL -- North arrow is required on the display as part of the display base.

-- This is not currently implemented. See Section 4.3 (S52 A2 3.2.2b 9) for specific implementation requirements.

**S52 A2 3.1.5** [1] -- FAIL -- Where charts at different scales overlap, the ECDIS display will show two scale boundaries, at the beginning and end of the overlap, and part of the display will often be grossly overscale.

-- Currently all chart boundaries are shown as bold dotted lines. See Section 4.1 (S52 6.3a) for more details.

**S52 A2 3.2** New symbols for ECDIS (introductory information).

**S52 A2 3.2.1** [1-2] -- FAIL -- ECDIS must provide the mariner with the option of using either the traditional paper chart symbols or the new simplified symbols.

-- This is not currently implemented.

**S52 A2 3.2.1** [1-2] -- PASS -- Simplified symbols should be used when the standard display is shown on initial switch-on.

**S52 A2 3.2.2a i** [1,3] -- FAIL -- If the mariner does not select a safety contour, the value should default to 30 m.

-- This currently defaults to 5.5 m.

**S52 A2 3.2.2a iii** [1] -- PASS -- Isolated dangers are highlighted by a special symbol.

**S52 A2 3.2.2b1** [1] -- PASS -- Simplified beacon and large beacon tower symbols (except cardinal beacons).

**S52 A2 3.2.2b 2a** [1] -- PASS -- Simplified buoy symbols (except cardinal buoys).

**S52 A2 3.2.2b 2b** [1] -- PASS -- Cardinal buoys and beacons.

**S52 A2 3.2.2b 3** [1] -- PASS -- General symbol for isolated underwater danger of depth equal to or less than the own-ship depth limit.

**S52 A2 3.2.2b 4a** [1] -- PASS -- Dredged channel symbol.

**S52 A2 3.2.2b 4b** [1] -- PASS -- Dredged area.

**S52 A2 3.2.2b 5 [1] -- PASS -- Radar conspicuous coastline.**

**S52 A2 3.2.2b 6a [1] -- PASS -- Prohibited area.**

**S52 A2 3.2.2b 6b [1] -- PASS -- Indication of caution.**

**S52 A2 3.2.2b 6c [1] -- PASS -- Unknown object.**

**S52 A2 3.2.2b 7 [1] -- Information available. -- Not observed.**

**S52 A2 3.2.2b 8a [1] -- FAIL --** Scale boundary shows where the scale of the available chart data changes. This should be marked with two lines, a thin line and a thick line. The thin line is on the small scale side of the boundary and the thick line on the large scale side. A chart index diagram is also required by S-52 (see S52, 6.3a). ECDIS should detect a scale boundary and prepare chart data at the next scale for display. It should also warn the mariner of upcoming chart scale change (see S52, Section 7).

-- Scale boundaries not implemented as specified. See S52 6.3a for more details.

**S52 A2 3.2.2b 8b [1] -- FAIL --** Should a display extending beyond the edge of a relatively large scale chart to include information from the next smaller scale chart, an area pattern should be applied to the entire grossly overscale part of the display. This pattern should not be applied to an overscale display deliberately requested by the operator. The identifying pattern is diagonal gray lines.

-- Identifying pattern for overscale areas not implemented.

**S52 A2 3.2.2b 8c [1] -- Change of units of depth. -- Not observed.**

**S52 A2 3.2.2b 9 [1] -- FAIL --** North arrow is required at all times and part of the Display Base.



-- This is not currently implemented. See Section 4.3 (S52 A2 3.2.2b 9) for specific implementation requirements.

**S52 A2 3.2.2b 11 [1] -- MARGINAL** -- The scale bar is a vertical bar, always 1.5 nautical miles in length, divided into three 0.5-mile segments, orange at top and bottom and gray in the middle. It should always be centered next to the left-hand border of the display. It should be displayed at scales of 1:80,000 and larger. A latitude bar should be shown at display scales smaller than 1:80,000 (see S-52 Section 3).

-- The current scale bar satisfies Phase 1 FUND tasking requirements specifically listed for the scale bar. However, FUND tasking also specifies meeting S-52 requirements as listed above. This inconsistency needs to be addressed. Also there is no latitude bar implemented at the present time.

**S52 A2 3.2.2b 13 [1] --** Border for non-HO chart data and End of Chart Data line.

-- This could not be determined at the present time.

**S52 A2 3.2.2b 14 [1] --** Identifying pattern for area with no data.

-- This could not be determined at the present time.

**S52 A2 3.2.2b 15 [1,3] -- MARGINAL** -- Identifying pattern for depth areas less than the safety contour. A diamond-shaped pattern of subdued gray lines is provided in the Presentation Library to identify areas of depths less than the safety contour for use as a mariner's option. Mariner should be made aware of the problem of discrimination of depth areas in some situations during the night display.

-- This is not currently implemented, but may be addressed in Phase 3.

**S52 A2 3.2.2b 16 [1] --** Rocky intertidal foreshore. -- This pattern was not seen.

**S52 A2 3.2.2b 17 [1] --** Pack ice area. -- This pattern was not seen.

**S52 A2 3.4 [1] -- MARGINAL --** Text as part of the route monitoring display.

Alphanumeric information should be used on the route monitoring display only when unavoidable, since it has to be written large enough to be readable and so causes clutter. Sizes, colors, and fonts to be used are specified in the Presentation Library. Alphanumeric characters should always be upright and written horizontally. Some alphanumerics are treated by the Presentation Library as symbols to ensure they are legible and correctly located.

-- The place names displayed are not written upright and horizontally. However, as they are not part of either the display base or standard display, they can be classified as additional information and treated as an optional feature during route monitoring.

**S52 A2 3.5 [1] -- PASS --** Instructions for using a separate text panel on the same screen as the main route monitoring display.

**S52 A2 3.6 [1] -- PASS --** Instructions for using a text display on a separate auxiliary screen from the main route monitoring display.

**S52 A2 3.7 [1-4] -- MARGINAL --** The controls and user interaction procedures for ECDIS should be designed following ergonomic principles for user-friendly operation. There should be enough in common from one manufacturer to another that a pilot, or newly joined deck officer, will not experience difficulty in operating an unfamiliar make of ECDIS. The controls should be usable at night without requiring illumination that affects night vision or distracts attention from the main graphics display. A dimmer control should be provided if the controls require lighting.

-- See Section 3.1 (PS 10.4) for areas of concern.

The remainder of Appendix 2 pertains to issues better evaluated in Phase 2 of FUND.

## **5.0 CORRELATION OF FUND PHASE 1 WITH FUND TASKING REQUIREMENTS**

### **5.1 Requirements for Phase 1 (P1)**

**P1 4.2.1 FAIL** -- Route monitoring and intelligent screen refresh.

-- See Section 3.1 (PS 10.5) for specific information.

**P1 4.2.1.1 PASS** -- Automatically update the screen with the current ship's own position.

**P1 4.2.1.2 PASS** -- Automatically use the library with the best scale data.

**P1 4.2.1.3 PASS** -- Automatically change screen scale based on the library scale.

**P1 4.2.1.4 PASS** -- Automatically refresh display based on ship's distance from the edge of screen.

**P1 4.2.1.5 PASS** -- Allow operator to manually override the auto library selection.

**P1 4.2.2 PASS** -- Voyage recording.

**P1 4.2.2.1 PASS** -- Keep a log of all data from Global Positioning System (GPS) receiver at a minimum interval of 1 minute.

**P1 4.2.2.2 PASS** -- Keep a log of all user changes to the screen display.

**P1 4.2.3 MARGINAL** -- Scale bar.

-- The Phase 1 goals stated for the scale bar are met; however, the requirement specified in Section 4.3 (S52 A2 3.2.2b) contradicts P1 4.2.3.1 (below) and is not met.

See Section 4.1 (S52 6.3c) and Section 4.3 (S52 A2 3.2.2b) for specific implementation requirements.

**P1 4.2.3.1 PASS** -- Display a bar which represents 1, 10, 100, or 1000 nautical miles.

-- According to Section 4.3 (S52 A2 3.2.2b), the scale bar is to be 1.5 nautical miles in length.

**P1 4.2.3.2 PASS** -- Bar will be color-coded to represent real-world distance.

**P1 4.2.4 MARGINAL** -- Position information: current own ship latitude/longitude will be continuously displayed on screen.

-- This can be removed from the screen at user request.

**P1 4.2.5 PASS** -- Spatial query: ability to show all database information on any information displayed on the screen.

**P1 4.2.6 FAIL** -- Base and standard display.

-- See Section 3.1 and 3.2 (PS 3.2, PS A2 1, and PS A2 2) for specific requirements.

**P1 4.2.6.1 FAIL** -- Base display shall be as defined in S52 Appendix 2, 3rd Edition, COE-CEDD/6/24 Add.1 with IMO features mapped to DNC.

-- See Section 3.2 (PS A2 1) for specific requirements.

**P1 4.2.6.2 FAIL** -- Standard display shall be as defined in S52 Appendix 2, 3rd Edition, COE-CEDD/6/24 Add.1 with IMO features mapped to DNC.

-- See Section 3.2 (PS A2 2) for specific requirements.

**P1 4.2.6.3 PASS** -- Operator shall be able to select between Base Display and all or part of the Standard Display.

**P1 4.2.7 PASS -- True/Relative Motion (PS 7.2).**

**P1 4.2.7.1 PASS --** In true motion mode, the chart shall remain in a fixed position on the screen while the ship moves on top of the chart.

**P1 4.2.7.2 PASS --** In relative motion mode, the chart shall move behind the ship while the ship remains at an operator-defined position on the screen.

**P1 4.2.7.3 PASS --** The operator shall be allowed to change the motion mode at any time while route monitoring is active.

**P1 4.2.8 PASS --** Best scale data (PS 10.3): At each own ship positional update, examine the available libraries and automatically retrieve and display the library with the most accurate data for the current ship's position.

## **5.2 Requirements for All Phases (PA)**

**PA 4.1.1 MARGINAL** -- Conform to ECDIS standards (the ECDIS Performance Standard and S-52) with the exception of S-57 (DX90) capabilities. The FUND project will use the DNC database.

-- See Sections 3 and 4 for specific information about compliance with these standards.

**PA 4.1.2 PASS** -- Execute on an HP UNIX Workstation at a reasonable performance with the following minimum specifications:

**PA 4.1.2.1** Processor performance comparable to HP 750 series.

**PA 4.1.2.2** 3GB hard disk capacity.

**PA 4.1.2.3** 64MB RAM.

**PA 4.1.2.4** Maximize the portability of the final software product to other UNIX platforms. If any software must be HP-specific, DMA shall be advised.

**PA 4.1.3 PASS** -- Execute in C software utilizing X/MOTIF operating in IIP-UX(UNIX).

**PA 4.1.4 PASS** -- Provide full-screen display of DNC.

**PA 4.1.5 PASS** -- Allows for GPS input in NMLA 0183 format.

**PA 4.1.6 PASS** -- Provide for independent control of up to four displays dependent upon system resources.

**PA 4.1.7 NA** -- Utilize the DMA standard selected for Vector Product Format updating.

-- This cannot be evaluated until a later phase.

**PA 4.1.8 NA** -- Utilize the DMA standard selected for symbology.

-- This cannot be evaluated until a later phase.

**PA 4.1.9 FAIL** -- Include Software Users Manual.

-- This is not yet incorporated.

**PA 4.1.10 FAIL** -- Include Software Programmers Manual (SPM).

-- This is not yet incorporated

**PA 4.1.11 FAIL** -- Display the logos for DMA, Naval Oceanographic Office (NAVOCEANO), CNMOC, Naval Sea Systems Command (NAVSEA), Space & Naval Warfare (SPAWAR), and others as directed by DMA.

-- This is not yet incorporated

**PA 4.1.12 FAIL** -- Incorporate Naval Oceanographic Office's (NAVOCEANO) supplemental layer data to be DNC interoperable with ship's own movement.

-- This is not yet incorporated

## 6.0 GENERAL COMMENTS

Installation instructions were not provided. Several problems came up during installation and testing of the FUND software. File permissions had to be changed in several instances. These problems could be more easily overcome if an installation guide were supplied.

Minimal user guidance; The 3 page DNC Demo Instructions provided minimal user guidance, but was sufficient to enable the evaluation.

On-line help was minimal.

All compact disk mounting and unmounting had to be done at the command line.

## 7.0 CONCLUSIONS

1. Installation and user's guides should accompany the FUND software.
2. The requirements documents contained redundancies. It is important to realize that upon the correction of one problem, many of the others will be corrected as well.
3. Many deficiencies relate to Display Base and Standard Display contents. The FUND tasking requires Display Base and Standard Display conformance to S-52 for Phase 1, but some items contained within these are specified to be included in later phases.
4. S-52 requires a scale bar that conflicts with what is specified in FUND Phase 1 tasking.



5. Lack of chart scale change boundaries; All the chart boundaries were present, but the boundaries that indicated where scale changes would occur were not marked as specified by S-52.

6. There is no legend as required by S-52. However, many of the legend components appear in various parts of the display.

7. Numerous other minor deficiencies are noted in Sections 3-5.

8. Although some issues need to be resolved, FUND Phase 1 provides a strong demonstration of the potential application of the DMA's Vector Product Format-based Digital Nautical Chart to ECDIS with greater performance capabilities than stipulated in the Phase 1 tasking.

## 8.0 REFERENCES

- [1] International Hydrographic Organization, *Specifications for Chart Content and Display Aspects of ECDIS*, Special Publication No. 52, 4th Edition, December 1994.
- [2] International Hydrographic Organization, *Guidance on Updating the Electronic Navigational Chart*, Special Publication No. 52 Appendix 1, December 1994.
- [3] International Hydrographic Organization, *Provisional Colour and Symbol Specifications for ECDIS*, Special Publication No. 52 Appendix 2, October 1993.
- [4] International Maritime Organization, *Performance Standards for Electronic Chart Display and Information Systems*, MSC Circ. 637, 27 May 1994.

## **9.0 ACKNOWLEDGMENTS**

The authors wish to thank Mr. Jerry Boatman from CNMOC for funding. Thanks are also extended to Mr. John Lanier, Mr. Steve Hall, Mr. Edwin O. Danford, Mr. Jim Ayres, and Mr. Doug McCusker of the Defense Mapping Agency for their assistance.

Thanks also to Mr. Robert Greer of NISE East for his assistance, and Mr. Mikan Stamenkovich and Mr. Dave Grant also of NISE East for their technical support.